

ON THE USES OF TEA IN THE HEALTHY SYSTEM.

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I have the honour of asking your attention to-night to the consideration of a substance of most general use in this and many other countries, which is an adjunct to food, rather than food itself, but which, by the social arrangements now existing, and the taste which has been acquired for it, is regarded almost as a prime necessity of life. It ranks amongst foods, in the estimation of the community, as high as cotton is held amongst the raw staples demanded by our manufacturers; and indeed it would be difficult to know which of the two would be retained if the nation were called upon to sacrifice one or the other. The characteristic of the food of an Englishman has heretofore been roast-beef and beer; but, without interfering with the pre-eminence of those substances, we may certainly now add the further characteristic of tea, if, as in our laws, the female is held to be included in the male, and the term Englishman comprehends also that of Englishwoman.

Hence, I am relieved from any necessity for a lengthened introduction to our subject, and may at once proceed to consider the mode of action of this valuable substance upon the human system, with a view to determine the conditions to which it is, or is not, fitted; and to this I propose to add some observations to the ladies on the selection and preparation of tea for the table.

We have the authority of the most populous nation in the world for the statement that "tea is an exceedingly useful plant," and "that if we drink it the animal spirits will become lively and clear." They also affirm that it tends to "clear away impurities, to drive off drowsiness, and to remove or prevent headache." The Chinese have used the plant for more than 1,200 years; and, therefore, must have had, even with their notions of time, a good opportunity of forming a correct opinion upon its merits. We, also, a nation situated in a different climate, and living under very different conditions, have some experience on the same subject; for since the days of Charles II., some two centuries ago, when 2 lbs. of tea was a choice present for a Queen, we have reached a period when each man, woman, and child in the kingdom drinks, on the average, more than twice that quantity each year, and when the total British annual consumption

of tea is upwards of eighty-six millions of pounds, and have arrived at the same conclusion—for that tea is "the cup which cheers and not inebriates" is a statement found amongst our household words. If to this conjoined testimony we add that of the extension of its daily use to the vast regions of Asiatic Russia, America, and Australia, and the increase in its consumption by every European State, we must admit that a remarkable unanimity exists as to its kind and degree of value for the welfare of mankind. Let us now seek to ascertain the mode of its action.

The late excellent writer, Professor Johnstone, in an article in his "Chemistry of Common Life," sought to explain its utility by reference to its chemical composition; and after discussing the effects of its principal ingredients, viz., the volatile oil, the theine, the tannin, and the gluten, arrived at the conclusion that tea lessens the waste of body by the theine, and supplies flesh-forming material by its gluten. He says, (but you will bear in mind that Professor Johnstone was a chemist, and not a physiologist) "the waste of the body is lessened by the use of tea, and if the waste be lessened, the necessity for food to repair it will be lessened in an equal proportion. Tea, therefore, saves food—stands, to a certain extent, in the place of food." This is a most important statement, and has reference to the theine as the peculiar active principle of tea, and to the gluten which is found in the leaves of tea and of other plants. He refers to the practice of the Tartar tribes, who drink the tea leaves powdered and dissolved in water, with salt and fat, and eat them with milk, butter, and roasted meal, and states that tea (but mark the other components), "first directly nourishes by the gluten and milk and meal it contains, and second, it makes this food go further by virtue of its theine." In further illustration, he cites the very utilitarian, and, if his statement be true, the rational mode of taking tea adopted by some of the inhabitants of South America, who, after drinking the infusion, eat the leaves.

This view raises a new question in the use of tea—one which seems to have escaped the attention of the Chinese, and is not found even in those mines of truth, the homely sayings of our own land, for it is said "to cheer,"

but it is not said "to nourish or fatten," and it is affirmed to "remove impurities," which must mean the removal of wasted and useless material, and not the supply of new material for digestion and transformation. Beers have been found to fatten the body, but it would be a new thing to feed a person on tea. We should expect such a person to become "small by degrees and beautifully less." Hence it is important to consider how far this statement, as to the nutritive properties of tea, is borne out either by the chemical composition of the leaf or by actual scientific observation of its effects upon the human system. The statement that tea cheers and removes impurities manifestly implies that it increases the transformation of food or tissue, for to cheer implies increased nervous action, and to remove material implies waste of the body; and hence, on the one hand, popular experience informs us that tea causes waste, and, on the other, science is appealed to to show that tea nourishes the body. Either these opinions contradict each other; or, as it may be possible to show, they are both, in a degree, true.

There are thus three questions raised in reference to the influence of tea:—

1. The waste of the body is lessened.
2. The body is nourished.
3. By lessening waste we may lessen supply, and yet the bodily powers shall be duly sustained.

We will first offer a few remarks upon each of these questions.

Now as to the value of theine, or the active principle of tea, in retarding waste of the body. It is to be observed that it has been deduced from the statement that it lessens the amount of nitrogenous or flesh-forming material which is thrown out of the body, and this has been stated on the authority of many, and is held to mean that thus the waste of the flesh of the body is lessened.

This last assertion was the opinion which Liebig introduced, and which has, until recently, controlled the scientific world. But now it is known that the waste of nitrogen, or the so-called flesh-forming material which is said to be lessened by tea, depends clearly upon at least three things:—1. The destruction of those tissues of the body which are composed of nitrogen; 2. The mere kind of food taken, as gelatine, for example, which, whilst it has small power to nourish the body, increases largely the excretion of nitrogen; and 3. Quantity, or perhaps excess of food, for two distinguished members of this Society, Messrs. Lawes and Gilbert, have shown incontestably that, if two pigs are fed on foods varying in the amount of nitrogen which they contain, they will differ in the same proportion in the amount of nitrogen which they will throw out. When, therefore, the excreted nitrogen may proceed from excess of food, or kind of food, or perhaps from unassimilated food, as well as from the tissues of the body, it is idle to regard its diminution as necessary evidence of the lessened waste of tissue. Hence, Prof. Johnstone's grounds for commending the use of tea cannot be conceded.

The different methods of inquiry to which I referred in my former paper are doubtless the causes of the discrepancy and errors in the results obtained by various observers. When doses of tea are added to, or given in place of, substances of unknown influence acting upon the system at the same time, it is impossible to determine their separate effect with certainty. As well might a banker keep the accounts of a particular customer, who had paid money into, and received money out of, the bank during the day, by placing to his debit or credit whatever difference might appear in the general cash at the end of that day, as compared with the amount noted at the end of the previous day, when hundreds had also paid in and received out variable sums on both days. Yet such has been the method adopted by those who affirm that tea lessens the waste of the body.

Böker, whose experiments are more extended than those of any other observer, when comparing the effects of tea and coffee with other foods, fell into the great error of omitting a pint or even a quart of milk for breakfast when

he took tea or coffee, and of drinking it when he would compare the two sets of results together. Now, tea and coffee offer scarcely any nitrogen to the system, whilst milk gives 44 grains in every pint, and hence he might well find that less nitrogen was given out when tea or coffee was taken than when milk was taken, but without at all showing that the tea or coffee lessened the excretion of the nitrogen.

But opposed to these results we have those of Professor C. G. Lehmann and my own. Professor Lehmann, a most distinguished German chemist and physiologist, and the most distinguished writer on physiology on the Continent of Europe, found the contrary, and proved that tea increases the emission of such compounds; and he remarks that he cannot say whether this was due to the increase of all the vital actions of the body which accompanied its use, and which would cause increased waste of all kinds, or to the nitrogen which it contained, and which, being in excess of the wants of the body, would thus be thrown off.—(*Physiol. Chemistry*, Vol. II., p. 419.)

In some experiments which we made upon four prisoners, kept under absolutely uniform conditions, to whom we gave tea and coffee each for three days during a part of the inquiry, we found a diminution in the excretion of nitrogen but for one day only, and at the end of the six days the quantity was more than 30 grains per day greater than it had been on the day before the experiment began, as is shown in the diagram on the wall. During this period, however, there was no diminution in the quantity of water eliminated.

That there is increased and not decreased vital action due to tea is familiar to us in its effect in preventing sleep; and is affirmed by the Chinese, when they state that "if it be drunk too freely it will produce exhaustion and lassitude," and if there be increased action in the body, there must be increased waste, as surely as that a wheel cannot be driven round with increasing velocity without causing increased friction, and increased waste of its own structure, or of the lubricating oil, or of the substance upon which it revolves. Hence we think that on this evidence the property of theine in retarding waste, and thereby lessening the necessity for food, must submit to the Scottish verdict of "not proven."

Then as to the gluten, which is said to nourish the body. Good tea leaves contain 20 per cent. of gluten, but boiling water will take up only 16 per cent. of the leaf, including all the four substances already referred to, and hence the amount of gluten which we actually drink in an infusion of tea cannot exceed about 8 per cent. of the weight of the tea leaves employed. Now, if we use the eighth part of an ounce of tea, or 55 grains, the total available gluten would be about four grains, and this quantity contains two-thirds of a grain of nitrogen. If we assume that the quantity of tea employed at a meal is twice that just mentioned, and that it is taken two or three times a day, we shall see the utter insignificance of its gluten when compared with the 250 grains of nitrogen which is otherwise supplied in food and also evolved from the body daily. Hence it is quite clear that we cannot regard tea as a nutritious food simply because it affords this very minute quantity of nitrogen or flesh-forming material; but although the theory cannot be sustained on the ground indicated, we hope to be able to show that there is a sense in which tea by its gluten may improve nutrition, whilst in other conditions it may waste the system.

The real ground of Professor Johnstone's theory is not, however, the quantity of nitrogen supplied, but the indefinite assertion that by some unknown means it lessens the waste of the system.

Now, as to the advantage of lessening waste and supply. Having very recently in this room had occasion to discuss the question of waste, I will only now remind you of the fallacy of assuming that in a state of health you may lessen the waste for a long period with benefit to the system, for there must manifestly be a proper balance maintained between want and supply, and if you lessen both, as Professor Johnstone

thought was the desirable action of tea on the aged, you lessen the vital action—in fact lessen life. All agencies (if there are any such except inaction) which lessen waste are only to be used in an emergency, until a due supply can be obtained, and due waste be again permitted, and such are states rather of disease than health. A merchant may be glad to find a diminution of his liabilities (or waste), but he does not look with complacency upon a proportionate and co-existent diminution of income (or supply): for whilst the one will still balance the other, he knows that it proves that his transactions are fewer and his business falling off, and that soon things will be so nicely reduced, and yet balanced, that he may close his doors. Just so it is with the human system—there must be a due amount of vital action both in supply and waste, and neither can be lessened without danger.

Hence, taking into account the known stimulating action of tea, the sources of error in the investigations heretofore made, and the results of Professor Lehmann's, as well as my own researches, I venture to affirm that there are no good grounds for stating that tea lessens the waste of the body; but I believe that it increases the products of excretion, whether from food or tissue, by increasing the vital actions. Whether this increased waste will really cause loss of weight of the body, will depend upon the amount of food supplied and the capability to transform it. Mr. Milner, surgeon to the Wakefield Gaol, in a paper which he read before the British Association in Leeds, in 1858, showed that the prisoners lost weight on the average, in a greater degree, when tea was given either in place of gruel or in addition to the gruel, a fact which shows both the direction of the action of the tea, as just indicated, and the very even balance maintained between the waste and the supply of the system in the usual dietary of these prisoners. To this question I shall again refer.

But we must not pass without notice the remarks made by Professor Johnstone on the volatile oil found in tea. This principle, although it has not yet been separately investigated, has doubtless the greatest value. It gives the flavour and odour to the tea, and upon its quality the monetary, but not necessarily the dietetic, value of teas in the market and on the table is determined. The theine and the gluten are not considered by tea merchants, and the quantity of theine is not determined by the taste. To this substance is to be attributed the headaches and nervous derangements of tea tasters, who, be it observed, only taste and do not swallow the tea, and it is said to cause even paralysis in those who have the constant duty of handling tea. Hence it is impossible not to attach great value to this substance when considering the ingredients of tea which act upon the body—an importance quite as great as that which we in a former paper attached to the aromas of pure wines; and I regret very much that I have not had the opportunity of making separate experiments upon it. The Chinese find it the most abundant in new teas, and knowing its powerful and deleterious influence, they do not use tea less than one year old, by which time it is presumed that a quantity of the volatile oil has become dissipated. The amount of it found in the dried leaf is said to be about 1 per cent. There are *prima facie* grounds for thinking that its action is that of a narcotic, and, therefore, opposed to some of the other ingredients, such as the aromas of wines have a similar action, and are quite different from that of the alcohol associated with them.

Being fully impressed with the desirability of setting at rest various questions which have arisen as to the action of our ordinary food both in the interests of the whole community and in those of science, I have during the past years prosecuted a new series of many thousands of inquiries, the details of which have been published in the Transactions of the Royal Society for 1859.

The direction of the inquiries referred to, but not made, by Professor Johnstone was, as already mentioned, the determination of the amount of nitrogen or flesh-forming material thrown off by the body under the influence of the food

in question, and as it was found that the evolution of that substance was decreased, it was assumed that the tissues of the body were undergoing less than the usual amount of waste. The direction which we have chosen has embraced the other great function, viz., the heat-forming function of the body, and has been effected by determining the amount of chemical change proceeding in the respiratory or heat-forming process, it being understood that with increased chemical change there will be increased production of heat and increased waste of food or tissue. As these are the two chief functions of the body, it is of importance that the influence of any special food upon both of them should be investigated before any attempts are made to apply the knowledge gained from either of them to practice, and by the two sets of inquiries now referred to we believe that this has now been effected. It will, however, be evident that in such inquiries there is a great liability to error, from the unknown and co-existent influence of other causes, and therefore the food experimented upon should be taken only in the quantity which man is accustomed to use, and apart from any other food, and in conditions of body which will be uniform, and interfere as little as possible with the vital actions. In the inquiry now to be referred to, we took a moderate quantity of the tea, and took it alone, while the body was at perfect rest, and in the sitting posture. It was also taken in the morning before breakfast, when the system is the most sensitive to all impressions, and when therefore the effects of the food could be distinctly appreciated. Various other precautions were taken to avoid error, but this short description of the method employed may suffice to show both the kind of inquiry and the degree of confidence to which it is entitled.

The experiments embraced the action of tea in various doses, from 25 grains to 150 grains, black and green tea—cold and hot infusions—with or without the addition of sugar, acids, and alkalies, and taken alone, as before mentioned, or after having taken other substances, as alcohols; and, indeed, under every circumstance which in any way bore upon the habits of mankind.

When tea of the finest quality was taken in the moderate dose of one-eighth to one-quarter of an ounce, infused in 10 ounces of boiling water, and drunk without any addition whatever, it uniformly, and in every experiment increased the respiratory changes, so that there was an increase of from one-quarter to one-fifth in the quantity of carbonic acid which was evolved by the lungs. This increase was rapid, and followed a definite course, so that with a perceptible effect in ten minutes, the greatest effect occurred in 45 or 50 minutes, and the whole effect subsided in from an hour to an hour and a half. There was in fact a progressive increase to a maximum, and then a progressive decrease until the whole effect ceased. With this increase in the chemical changes there was also increased frequency and depth of respiration, so that more air was inspired, and the act of respiration was performed with greater ease, frequency, and completeness. The sense of "lightness" was very marked, and was chiefly referable to the ease of respiration, whilst the cheerfulness which we have already quoted was uniformly and delightfully present. It will interest those who have adopted the system of small doses in physic to know that small doses of tea also when often repeated, have greater effect than one large dose: so that 25 grains, or a small pinch of tea, when taken every quarter of an hour for six doses, produces fourfold the effect of 150 grains taken at once, and the action is much more uniform and sustained. It is also worthy of remark that the quantity which we ordinarily take is that which produces the greatest effect, for 50 to 100 grains usually produce a greater effect than 150 grains. The latter dose became indeed a poisonous one, for it sometimes induced a distressing temporary nausea, and at others a moderate amount of narcotism. It is well that the student who wishes to maintain mental activity under difficulties should be informed that tea will aid him far better when drunk in sips over a lengthened period than in the larger quantity taken within a few minutes at ordinary meals. It

is also remarkable that this substance does not increase the frequency or force of pulsation when taken in moderate doses; and to the absence of increased pulsation must be attributed that calmness which attends upon, and greatly adds to the value of, the cheerfulness which results from the use of tea. These various effects are shown upon the Diagram placed at the end of this paper, on which the results of numerous experiments are delineated, and to which we invite a little patient attention.

The number of experiments made by us amount to many hundreds, and far exceed all that has been recorded by all previous inquirers, and in no instance were the results different from those just described. Hence it is impossible to doubt even, much less to deny, that tea increases the respiratory function. But those observers who have affirmed that tea lessens the amount of nitrogen evolved, also affirm that it lessens the amount of carbonic acid produced, but, as I have observed in the paper on alcohol, Prout and Hammond obtained only the percentage, and not the total amount, and others mixed up the influence of the tea or the alcohol with ordinary food having an unknown influence. I appeal with confidence to the diagrams before you, to the method which we adopted, and to your own sensations as proofs of the fact that tea increases the respiratory changes, and that in a marked and uniform degree.

I have elsewhere shown that the increase in the carbonic acid evolved under the influence of tea could not have been obtained from the tea itself, for, independently of the rapidity of the effect, the quantity of carbon evolved was much greater than was contained in the tea. Hence the very important deduction follows, that tea has the power to increase the transformation of other food, and particularly of such as contains carbon. This is probably due to the gluten which the tea contains, and which acts as a ferment.

Another kind of action, of great importance, is that which tea exerts in increasing the function of the skin, as is seen by the perspiration which often follows its use. This is the explanation of the fact which is taught by the Chinese when they say that "tea is of a cooling nature" and may be freely drunk under a burning sun, a statement with which popular experience in this climate fully agrees, and it is due to a physical effect which may be thus explained: When a fluid is converted into vapour it absorbs, during that conversion, 1,000 times as much heat as it required when in its fluid state, and as this heat is rendered latent, and is essential to the constitution of the vapour, it must be abstracted from the surrounding objects and thus reduce their temperature. The action of the skin is chiefly that of regulating the temperature of the body, partly by the direct radiation of heat, but chiefly by this process of evaporation, and the rapidity with which the latter is carried on, measures the sensation of cold which will attend the abstraction of heat from the surface of the body. In this point of view the skin is the most important organ in the body, for as it regulates the heat of the body, so it must regulate the activity of all the internal organs which produce the heat and control the necessity for food, or fuel for the fire. The uniform action of tea, when it agrees with us, is to increase the rapidity of evaporation, and in hot weather, and when taken with hot water, the perspiration is often times very profuse, and the subsequent cooling proportionately rapid.

This valuable property of tea is perhaps instinctively modified by various nations, according to the wants of the consumers, those wants varying with temperature and also with the amount and kind of food which is attainable by them. Thus, the Chinese inform us that "the country people," viz., those exposed to great temperature, but without abundant food, "before drinking it, add ginger and salt to counteract this cooling property;" whilst the Russians, living in great cold, add an acid, as lemon-juice, and in this country we add cream. The mode of action of all these additions is the same, viz.: their tendency to restrain the action of the skin, and thereby to coun-

teract this special effect of tea. It is known that the opulent Chinese drink a plain and weak infusion by sips in the circumstances in which they are placed, and this can be well defended by the experiments now recorded; but it has not been hitherto known why we, inhabiting a different climate, add milk or cream to our tea with the same effect. If any one will notice the effect of a basin of milk when taken alone, he will find that the hands and the exposed parts of the skin become hot and dry, and will at once appreciate the fact that the addition of milk or fat to tea has the effect just mentioned—that of preventing the increase of perspiration and thereby the cooling of the body.

I do not know of any evidence to show that alkalies are ever added to tea with an intelligent view to the opposite state—that in which the action of the tea upon the skin is increased; but many are familiar with the fact that in this climate we add soda in small quantities, or use soft waters, with the ostensible desire to obtain a more coloured infusion. Professor Johnstone, in reference to this habit, offers the chemical explanation of the more ready dissolution of gluten on the addition of an alkali, but we venture to ask those who adopt this plan to ascertain if it be not rather due to some instinctive desire to cool the body, and would also put the same question to those who are not in the habit of taking milk or cream in their tea.

As we have referred to this matter, it may be better to state that the sugar which we add to the tea tends largely to increase the action of the latter, both upon the respiration and the skin, sugar having indeed in some respects, an action very analogous to that of tea, both in nature and degree, so that the Frenchman drinks his sugar and water as the Chinese and ourselves drink tea. Hence in a cup of tea, as ordinarily drunk in this country, we take three ingredients besides the hot water, two of which coincide in their action, and one which is opposed to them. This habit is not practised in China, and there are many in this country who take only two of the three ingredients, but very few who take the tea alone.

Moreover, when ginger, acids, milk, or fats are added to the tea there is a tendency to increase pulsation—another mode by which the action of tea is opposed, and thus the tea becomes more stimulating, but when an alkali, as carbonate of soda, is added to the tea, the soothing property of it is increased.

Thus, on a review of the foregoing experiments, we observe that the two sets of inquiries into the action of tea are harmonious, and tea has the power to increase the amount both of carbonic acid and of urea evolved; and without occupying your attention with further detail, I may sum up the foregoing remarks by stating, that the *essential action of tea is to promote all vital actions and to increase the action of the skin*. Hence it increases the assimilation of food, both of the flesh and heat-forming kinds, and with abundance of food it must promote nutrition, whilst in the absence of sufficient food it increases the waste of the body.

Having thus arrived at the knowledge of the true action of this substance, we are prepared to endeavour to ascertain the states of body, or the external conditions in which its use is proper and improper, and whilst we think this will be an easy task, we hope to be able to show that much greater discrimination ought to be employed than has hitherto been observed.

The basis of this part of our inquiry is clearly the relation between the waste of the system and the supply of food to meet that waste, and this idea must be ever present in the mind during the discussion, for the foregoing remarks shew that as tea increases all vital action, it must increase the waste of the body, *unless there be a supply of food upon which it may first act*.

In pursuing this subject we must admit that tea is not applicable under the following conditions, viz.—

1. In the absence of food, for then it must increase the waste of the body. If, however, it follow a large meal, as the dinner, the system is then replete with food, and

although no food may be taken with the tea, the tea cannot be said to be taken in the absence of food.

2. At breakfast, except there remains unused food from the supper on the previous night, or except the system be usually too full of nutritive material, as in those who dine heartily at a late hour.

3. To the ill-fed, except there is also deficient power to transform the kind of food attainable.

4. To those of spare habit, in whom all the vital actions are performed with much activity.

5. To a prison or other dietary, in which it is a duty to society that the food supplied should not exceed the wants of the system.

6. To exertion, for exertion is itself the most powerful exciter of waste.

7. To low temperatures, except in connection with abundant food and clothing, and with the addition of milk, fat, acid, or ginger.

8. To those who habitually perspire too freely, unless (as is then seldom the case) there be an excessive supply of food.

9. To those cases in hot climates where the appetite is defective and the skin active.

10. To the young, in whom there is naturally the maximum amount of vital action.

11. With our principal meals, or those at which we take the greater part of our animal food, for after such meals a dry and hot skin, that is, lessened action of the skin, is a natural effect, and this would be opposed by the tea. It is worthy of note that neither the Chinese, nor any other nation, usually take tea under this last condition.

Such are some of the conditions in which tea should be withheld, and in reference to most of them the results of science correspond with actual practice. It is not usual to give tea to children, or with animal food, as at dinner, or at breakfast, or in prisons, and we seek a stronger beverage in hot weather and during exertion; but it is universally taken in the afternoon and evening, and after dinner, when the vital actions are declining and there is felt to be excess of food in the system. It is not taken alone as a meal, or with the idea of taking nourishment. Yet with all this instinctive propriety, the cautions now given are not universally adopted, and in such instances as in those who perspire freely, and those of spare habit, much ignorance prevails, to their own detriment.

The subject of low temperatures and exertion raises that of the fitness of tea to supplant spirituous liquors in the dietary of our sailors when residing in the Arctic regions, and has given rise to much difference of opinion. In a recent work on Arctic voyages, it is affirmed that after the first year's residence the appetite for food changed, so that large quantities of fat were consumed, and tea was found to be highly acceptable and beneficial. The explanation of this last fact appears upon the face of the statement, for it was the excessive quantity of fat which, by its action in lessening the activity of the skin, as well as by the necessity for its own transformation, rendered the action of tea desirable. Dr. Kane, in his interesting work, states that his crew were pledged to the avoidance of spirituous liquors, but in one period of exposure and fatigue of great danger, he gave them brandy; at another period, when great labour was temporarily required in great cold, he gave them hot coffee; and in their ordinary dietary he authorised tea, but he does not give any grounds for this variation. We are informed by an Arctic navigator of great experience and high position, Sir James Ross, K.C.B., F.R.S., that this large increase in the consumption of fat in the Arctic region is not necessary, provided the quantity habitually supplied to sailors is duly eaten; and it is quite clear that in the absence of an unusual quantity of salt or fat, or some other substance, which tends to lessen the evaporation from the skin, the use of tea is not especially indicated. The problem is one of a mixed nature, each part of which must be investigated before a truthful conclusion can be arrived at.

That sailors can do their work better with tea than with

other beverages cannot be, as already proved, because it supplies nourishment, but because it causes the avoidance of a disturbing and therefore evil habit, or promotes the digestion of food, as will be shortly pointed out.

We may now briefly look at the opposite view of the question, and point out the states in which the use of tea is clearly beneficial. These are—

1. Some time after a full meal, when the system is oppressed by food, or by the heat produced in its conversion.

2. In the after part of the day, when the body is full of partly-digested food, and when the activity of the transforming function is considerably lessened.

3. For the corpulent.

4. For some of those in whom the vital actions proceed slowly, and in whom the power of transforming food is greatly lessened.

5. For the old, with their deficient vital actions.

6. For hot climates, and especially to those who, living there, eat freely and drink milk or alcohols.

7. In cases of suspended animation, as from drowning, where the object is to restore the respiratory functions—an object more likely to be assisted by hot tea than by brandy.

8. For those who eat much starchy (bread, rice, &c.) and fat food, and especially if they do not take flesh. This is due to the fact that our experiments have proved that tea clearly promotes the transformation of starch and probably also of fat—in the former case by means of its gluten, which doubtless acts as a ferment in reference to the starch.

9. For soldiers, who in time of peace take too much food in relation to the waste proceeding in the body.

10. For soldiers and others marching in the heat of eastern climates, for then, by promoting evaporation and cooling the body, it prevents in a degree the effect of too much food and of too great heat. For this purpose a cold infusion may be used (as a hot infusion could not be obtained); of this a quantity equal to 25 grains of tea should be taken often during exposure. We urge this upon the consideration of our military authorities, in the conviction of its great value in preventing the occurrence of sun-stroke and of other diseased states of system due to excess of heat, and have entered into the subject more in detail in a short paper published in the *Medical Times and Gazette* for 1860.

11. For the sedentary, who require increased vital action.

12. For those who have usually a dry and non-perspiring skin.

All these conditions resolve themselves into this general law that tea is beneficial in all conditions in which there is temporary excess of food regarded in relation to the necessity of the system for it and the power to transform it.

Such is a concise view of the results of our enquiry into the influence of tea, and we cannot but think that it will suggest to thoughtful minds material for reflection and practical application. It is evident that the way the instinctive cravings of man find expression in the (right) use of this article of food, with singular unanimity, under the most diverse circumstances of climate and condition, confirms the truthfulness of scientific research, whilst at the same time there is much reason to fear that in our own country the indiscriminate employment of a substance which possesses great power, is daily leading a large portion of the community to their own injury.

We hinted, in the earlier part of this paper, at the possibility of showing that there is truth both in the statement made by Professor Johnstone and in those which are now offered, although the former asserts that tea nourishes, while the latter demonstrate that it may waste the system. The key to the solution of this enigma is found in the explanation of the source of the nitrogenous or flesh-forming material which is thrown out of the body under the influence of tea. It has recently been shown that this is partly due to the waste of tissue, partly to the

conversion of food, and partly to excess of food. Hence, if tea cause an increase, it may do so by the second method, and, therefore, whilst it does cause this increased waste, it at the same time nourishes the body, for it causes also the more perfect assimilation and an increased consumption of food. This explanation at once reconciles the two statements, but only in the conditions—1st, in which there is abundant food; and, 2nd, when food, whether sufficient or insufficient, is not properly digested or transformed. The sagacious Baron Von Liebig pointed out the analogy between the active principle of tea and the active principle of the bile, and both doubtless tend to the common end of promoting the digestion of food. All parties, be it remembered, agree that tea acts beneficially upon the system, and the only difference of statement is whether it acts by lessening the waste of the body, and, therefore, is useful only to the ill-fed, or, by promoting the transformation of food and removing excess, whereby it is more or less advantageous to all classes.

This is the truth at which our experiments have brought us, and we may close these remarks with a summary of the effects of tea in the following words: If there be an abundance of food in the system, and that especially of the farinaceous or fat kinds, tea is a powerful digestive agent, and by promoting the transformation of food it aids in nourishing the body; but with a deficiency of food in relation to the waste of the tissues by exertion, or the waste of heat by cold or by too profuse evaporation from the skin, it wastes the tissues of the body and lowers the vital powers. With deficient food, as in the case of the poor basket women, but with deficient powers of transforming or digesting it, tea will promote digestion and thereby indirectly nourish the system, although it will increase the vital actions. The three parts of the problem are want, supply, and transformation.

I must add a word in reference to those cases in which tea is not found to be beneficial. Tea is known to act very differently on different persons, and I am informed by one gentleman that he never takes it without finding an accumulation of water in his body, as shewn by a small dropsical effusion into the skin; and if retention of water were shown to be at all general, it would account for the temporary diminution in the excretion of nitrogen. The most distinguished medical man of the day, when asking if I had noticed any difference in the effects of green and black tea, expressed his conviction that the former was the more powerful. The explanation of this is clear—green tea, if fine, undoubtedly contains more of the chemical elements of tea than ordinary black tea, for it is commonly the young or newly-formed leaves, and is not fermented, but the true reason is the greater weight of green when compared bulk for bulk with black tea, so that one tea spoonfull of green is heavier than two of black. Hence those who drink green, drink very strong tea (comparatively colourless though it be), and it may well have greater influence upon them. Another very distinguished chemist informed me that after taking tea or coffee for a few days he became irritable and peevish, and was obliged to discontinue it for a short time. Many complain of the effect of tea upon the stomach, causing a grinding or gnawing pain, and leading to indigestion, and this is probably due to the tannin which is found naturally in tea, but more commonly added to it in the form of valonia, with a view to give it a rougher and stronger flavour. When it is taken for breakfast it more commonly causes indigestion, owing to the sensitive condition of the system, and the absence of any accumulation of food. The wakefulness which follows the use of tea in many persons is doubtless the effect of increase in the vital actions, conjoined sometimes with the above-mentioned effect upon the stomach, and it, in some degree, follows the use of any other agent which acts in a similar manner, but in many instances it is due to the action of the tannin upon the coats of the stomach.

I shall now close this discussion on tea with some remarks specially addressed to the excellent housewives,

without whose presence the tea-table would be cheerless, notwithstanding the enlivening properties of tea, and with all deference and courtesy offer the following suggestions for their guidance, when selecting and preparing this most welcome cup:—

First in the selection of tea.

There is both much ignorance and much mystery in nearly all minds in reference to the selection of tea. Generally, I believe, we are guided by the price, by our opinion of the strength of the tea, and by the quality which the tea dealer may chance to send. But it will not be difficult to point out a few particulars by which this evil may be remedied, and ladies be led to act with that intelligence in this which marks their conduct in other matters.

There are green and black teas, but they are all the product of the same kind of plant, yet the green tea is commonly produced in a different district from the black teas, and the different varieties of black teas are grown in different localities. In this respect it may be compared to wine, which we know obtains different flavours and qualities according to the locality in which it is produced, and yet all varieties are derived from the grape.

There are six kinds of green teas, viz., gunpowder, imperial, young hyson, hyson, twankay, and hyson skin, but all are produced from the very same tree. Thus, a green tea planter pulls all the leaves off the trees and mixes them together. They are then taken to the manufactory, where, being placed upon a heated plate of metal, twisted in various ways by the rotatory movement of the hand, and curled up in various degrees by the heat applied, a mixture is produced which contains all the kinds just mentioned. The leaves which are curled up the closest are sieved out, and this constitutes gunpowder, the next size above is the imperial, the next the young hyson, and so on to the twankay and hyson skin, which are the largest leaves, and thence the least curled by the process employed. As a rule, the younger the leaf the more readily and more completely it curls up, and hence the gunpowder is commonly the youngest leaf, and the twankay and hyson skin the larger and older leaves. This process may be roughly illustrated by referring to the manufacture of shot. The lead is melted at the top of a tower, and falls into water at the foot of the tower, where, on examination, it is found to consist of grains of various sizes. It is then passed through sieves having holes of various dimensions, and is separated into the numerous sizes of shot which are found in our shops. In both the manufacture of the tea and the shot alike, there is a common mass, and the final distribution is regulated simply by size. The teas thus assorted are packed in boxes, and the whole quantity, called a chop of tea, is sent to the market. The Americans are wise enough to take all the larger teas, which are cheap, and leave us the small teas, at a doubly or trebly increased price. Black teas gain their colour by fermentation, and are of three principal kinds, souchong, congou, and pekoe. Formerly there was also bohea, but that is not now brought to this country. The term pekoe means flower, but it is applied to specimens which do not contain the flower. Souchong and pekoe are the finest teas, but are comparatively rare. Congou is the kind of black tea almost universally sold.

It must next be borne in mind that, whilst there are so many kinds of tea, each kind is liable to vary greatly in quality, so that the mere name of the tea is no evidence of its real value. At this point, we see the importance of taste and technical knowledge as to the manufacture of tea which experience alone can give, for by this, and not by the name of the tea, the price is attached to it. Hence in selecting a tea, it is needful to remember that the qualities of even genuine tea vary so much that the quantity of its valuable constituents is nearly three times greater in the best than in the commonest kinds. Therefore, tea must not be accepted simply because it is tea, neither must equal quantities of a good or bad tea be employed. The best tea is that

which contains part of the flower and the youngest leaves of the plant. My friend, Mr. James Moul, informs me that the finest kinds of green tea, whatever the process of preparation, have a pale yellowish leaf. The infusion should be perfectly clear, without sediment, and should possess a delicate tinge of yellow. In black tea, the leaves should be of a reddish or brownish black, fragrant, and free from any artificial scent, and the infusion should be clear and of a bright red. The beautiful perfumes from artificially-scented teas, as, for example, orange-flavoured pekoe, are not derived from the tea—have no property in common with the tea, and are drawn out and dissipated with the first cup, and therefore are valueless, and to be avoided. The natural colour of the leaf, when growing upon the tree, is a dullish green, and hence amongst green teas, those which have a pale colour are more natural, and are generally those of the finest qualities, but the bright green teas are usually coloured artificially or glazed, and are not of the best qualities.

It will be found that teas differ in weight bulk for bulk, that is to say there will be more spoonfuls in a pound of one kind than in the same weight of another kind, as, for example, the heavy small, round leaf gunpowder as compared with the light, long, twisted, and wiry-leaf congou, souchong, and pekoe. To this I am anxious to ask your earnest attention for a moment. The common test of the spoonful is fallacious, both as respects the real amount of tea supplied and the relative cost of each day's consumption. One tea spoonful for each person, and one for the pot, as our mothers directed us to use, will make an infusion more or less strong, more or less valuable, and more or less costly, according to the weight of that quantity. I now show to you several specimens of teas, kindly furnished by Mr. Moul, and will prove to you in how great a degree the bulk and weight differ. The weight of a fairly and evenly taken caddy spoonful of each of these teas, and the number of tea spoonfuls in the lb., is as follows:—

BLACK TEAS.

	Grains.	Spoonfuls per lb.
Oolong	39	179
Inferior congou, large leaf...	52	138
Flowery pekoe.....	62	113
Souchong	70	100
Fine congou.....	87	80

GREEN TEAS.

Hyson skin	58	120
Twankay	70	100
Hyson	66	106
Fine imperial	90	77
Scented caper	103	68
Fine gunpowder	123	57

All these are pure teas except the scented caper. It is not presumed that the relation of these weights is absolutely true, for no two spoonfuls of the same tea would contain precisely the same quantity, but they are at least as near an approximation to the truth as is the actual result of any one measuring tea by spoonfuls in ordinary use. Hence it is seen, that even amongst black teas there are kinds which are twice as heavy as others, and when extremes are taken of black and green tea the difference of weight is more than three times. It is, therefore, unreasonable for the good housewife to expect to find the same strength and flavour from equal bulks of different teas, and if she should be induced to use more of a light than of a heavy tea, she may take comfort from the thought that she is not adding to her expenses, for if all the kinds above-mentioned were sold at the same price she might use two or three spoonfuls of black tea for the same cost as the spoonful of green, viz., fine gunpowder. Ignorance and inattention to this matter often cause the consumer to complain without reason to the tea dealer. It is very desirable, although not perhaps practicable, that tea should be used by weight and not by bulk, and the more so that there is no definite relation between variation

in weight and variation in quality of tea, except the general one just pointed out.

It is, however, to be well understood, that there is but little relation between the market value of the expensive kinds of tea and their true value upon the system, not such a value as would enable any one to state, that because a certain kind of tea is costly, it therefore contains more theine. The flavours of tea must be regarded as luxuries, just as we value the delicate and peculiar flavours of certain Rheish wines, and as the quantity of such tea is small and the supply variable, so most those pay highly for it who have taste enough to attach a high value to it. It is known that the teas of the choicest flavour are never exported from China, and from their great value are drank only by the wealthy classes, whilst the finest teas which are exported find their way by the Caravan route to Russia, and there sell at almost a fabulous price. Such teas when made weak may, without any difficulty, be drunk without milk and sugar, and then true bouquet and flavour are enjoyed in the same manner and degree that a connoisseur enjoys his finest wines.

But for all useful purposes it is better to obtain the good qualities of the so-called inferior kinds, as for example in green teas, the hyson skin, or young hyson, sold at 1s. to 1s. 6d. per lb., instead of the gunpowder sold at 3s. per lb. besides the duty. We may also fairly lay aside all prejudices as to the use of uncoloured green tea, since it must have occurred to you, on hearing this paper, that the color of the infusion is no test whatever of the quality of the tea; the pale infusion of the green tea often containing far more tea than the black infusion of highly dried and rough black teas. Of black teas I would strongly recommend the Oolong tea of good quality, for although the colour of the infusion is light, it causes a choice bouquet and is pungent without being rough to the palate. I am informed that dealers find some difficulty in disposing of this tea, for whilst its price is not low, its infusion being light, is ignorantly thought to be weak. It has also the merit of being a bulky tea, and one, therefore, in which the consumer may cheat himself into habits of economy.

Second, as to the quantity of tea to be infused.

We have already stated that a moderate is preferable to a large quantity, provided good tea be selected, but it is evident that a larger quantity of coarse leaf than of fine leaf tea must be employed. Of the very finest teas used in China, a small pinch is taken as the suitable modicum. The lower orders of the Chinese obtain only the coarser kinds of tea, but even these are of good quality as compared with our inferior teas, since they are not so highly dried as those which are exported. They drink tea thus prepared in very large quantities, and there are for their convenience multitudes of tea shops, where they may obtain a quantity of the inferior infusion of tea at a very small cost.

We advise that the tea be not made "stroug," but that it have a good body and fine flavour to the palate.

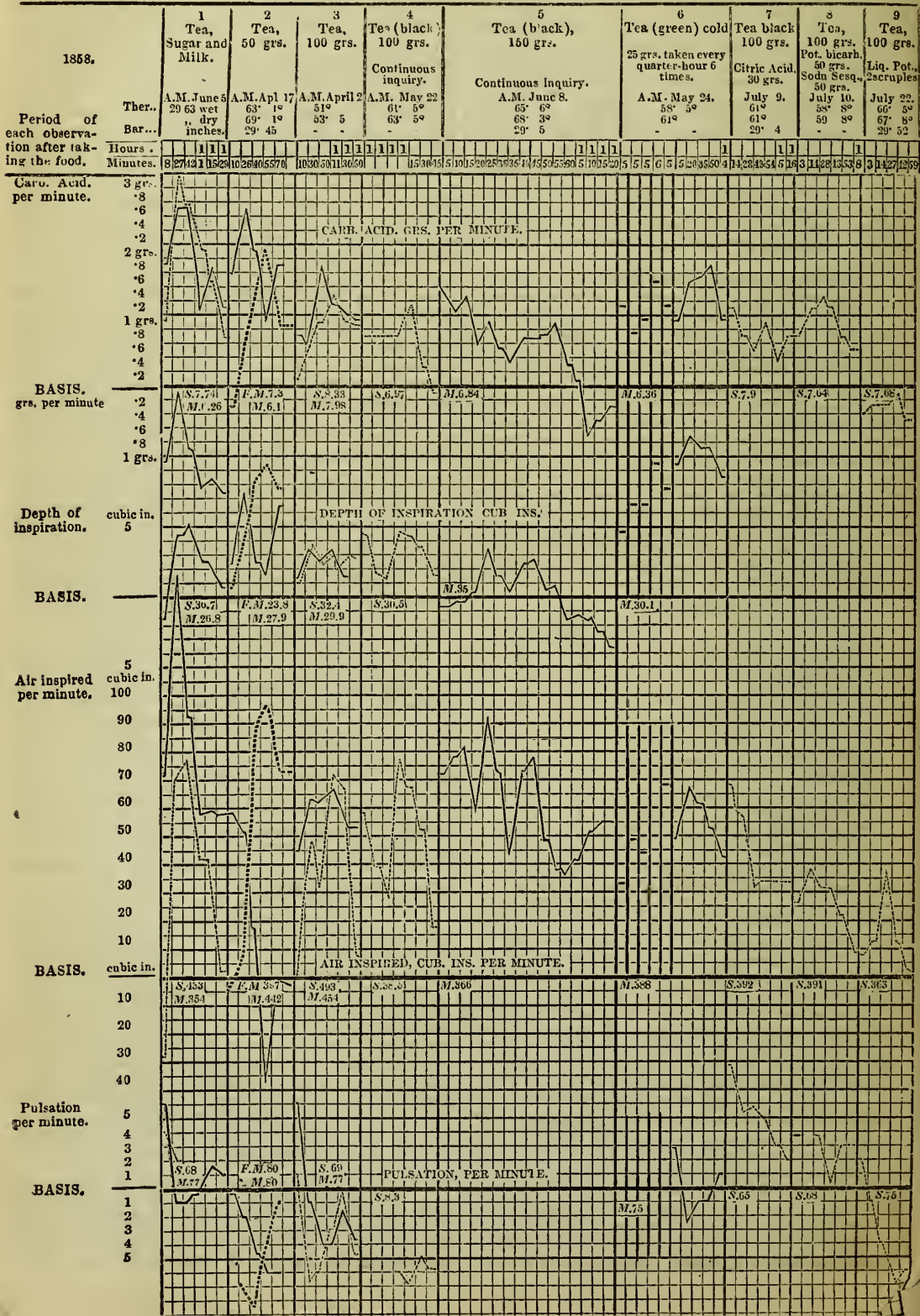
Third. The mode of preparation.

It is an invariable practice amongst professional "tea tasters" never to make the infusion with water which has been already boiled, but on the contrary to take fresh water and use it immediately it boils. We are informed by Mr. Fortune that the Chinese are equally careful on this point, and that very minute directions are given by their writers, thus:—"The fire must be lively and clear, but the water must not be boiled too hastily. At first it begins to sparkle like crab's eyes, then somewhat like fish's eyes, and lastly it boils up like pearls innumerable, springing and waving about." There may be something fanciful in this description, but it no doubt represents a truth in reference to the expulsion of the air which is naturally found in water, and we certainly commend the example to our gentle hearers.

Every good housewife knows too well the influence of kinds of water in making tea to render it desirable that we should dwell upon it, but we would recall to their minds that the water to be abhorred is stagnant and hard water, and that to be preferred is running and soft water.

Diagram showing the influence of Tea over the Carbonic Acid expired, and the quantities of Air inspired, with the Depth of Inspiration and the Rate of Pulsation.

Small Dotted Line—Dr. Smith. Black Line—Mr. Moul. Large Dotted Line—Mr. F. Moul. 0.05103 Inches = 1 Cubic Centimeter. The numbers near each basis line are the basal quantities. S. signifying Dr. Smith, and M. Mr. Moul. The minutes at which each experiment was made after the tea had been taken are recorded at the head of each Figure, as are also the Temperature with the wet and dry bulbs (Fahrenheit), and the Barometric indications.



The Chinese direction is imperative, viz.; "take it from a running stream, that from hill springs is the best, river water is the next, and well water is the worst." We fear that these directions will be in some degree lost upon those who live in our great towns, who must use water which is not always clear, pure, and soft. Let them, however, filter it, and add carbonate of soda to it—the least pinch in winter, and a little more in summer. With hard water it is impossible to make good tea.

I have only one word to add: viz., make the tea yourselves, and allow it to infuse for ten minutes.

It was my intention to have offered some observations upon the action of coffee, since it is so closely allied to, and yet in some respects so different from, tea; but the time allowed to me forbade my doing so. I would, therefore, in concluding this paper, offer one observation of general import. We must not, and we do not, regard the substance which have now been discussed in the light of ordinary food, for it cannot supply the place of food, and alone cannot nourish the body. Even admitting that the elements are not unsuited as food, the quantity which we take offers no proportion to the quantity of those elements which must be supplied to the body daily. Their real power is to modify the influence of true foods, and we have shown that in this respect they are most valuable. But there is another view of the matter which cannot be forgotten. The system requires from two to three pints of fluid per day to enable it to appropriate the solid food and to rid itself of waste and useless material. This must be taken as water alone or with such substances as tea and coffee infused in it, or as milk, or as some form of alcohol. We must either drink a quart of milk or a quart of beer per day, as our forefathers did, or we must use such beverages as tea and coffee. With this moreover, there is a call for increase of heat in the body, and particularly in cold weather, in the absence of food, and in the ill-fed. This is met either by the use of warm drinks or by fluids as beer or other alcohols, which stimulate and give a sensation of warmth within. It has often been asked why poor hard-working women relish their tea so greatly, and the answer has been either that it nourished them, or, by lessening the waste of their bodies, it enabled the food to go further. The true answer must contain three items: the tea cheers and increases vital action, enables the bread to be more quickly digested, and the heat of the fluid supplies a comfortable warmth. No fluid meets these requirements better at the same cost, but all would admit that if the poor could obtain hot milk it would be found to be far more beneficial.

In some experiments made upon myself, in which for several days I tried to live on bread and water only, I found it to be absolutely necessary that the water should be warmed, both that it should not abstract heat from, and that it should give heat to the body. Those only who have tried this can appreciate the value of warmth in our beverages, and may well pity the poor creatures too often hastily condemned for "prison" offences to the dark cell and bread and cold water.

Let those whose aim it is to lessen the amount of alcoholic drinks consumed by our hard-working poor people, bear in mind that some other suitable fluid should be found for them, and it would confer the greatest boon to teach them the true value of milk, and to increase the facilities by which hot, wholesome milk, tea, coffee, and cocoa, might be obtained in a comfortable and economical manner.

EXPLANATION OF THE DIAGRAM.

The diagram, extracted from the *Philosophical Trans-*

actions for 1859, exhibits the effects of tea upon three persons in good health, and in the morning before breakfast, and shows the quantity of carbonic acid in grains per minute expired by the lungs, the amount of air in cubic inches inspired at each inspiration, the total quantity of air in eubic inches inspired per minute, and the rate of pulsation per minute. The quantity of tea with the substances added to it, the temperature of the air, and the height of the barometer, are recorded at the head of each series of experiments. In all the experiments except those numbered 4 and 5, the carbonic acid was collected during five minutes at the periods recorded immediately under the heading, whilst in Nos. 4 and 5 the whole of the carbonic acid evolved was collected by several series of apparatus and weighed at the periods mentioned in the same place.

The thick perpendicular lines separate each set of experiments, whilst the faint lines separate each experiment in each series, and in No. 6 the shorter thick lines are placed between the records of the effect of each of the several doses of tea which together formed the whole experiment. The duration of each series varied from one to two hours, a period sufficient to show the maximum effect, whilst the interval between the commencement of one experiment and the beginning of the succeeding one was about 15 minutes, and the number of observations was six or seven in each series.

The horizontal series of lines upon the diagram are divided into the four sets abovementioned, viz., the carbonic acid, the depth of inspiration, the quantity of air inspired, and the pulsation. In each of these there is a thicker line, which is called the basis line because it indicates the amount which was recorded immediately before the food was taken, and the effect of the substances being greater or less than the basis is represented by the series of curves, (each one or two lines representing one or two persons experimented upon) above or below these basal lines. The amount constituting each basis differed with each person and with each experiment, and hence the curves show the increase and decrease and not the actual quantities, but in order that the actual quantities may be ascertained, the basis quantities are inserted in the diagrams at each basis line, the letter S. signifying Dr. Smith, and referring to the small dotted lines; M. signifying Mr. Moul, and referring to the plain lines; and F. M. signifying Mr. Frederick Moul, and referring to the larger dotted lines.

The figures on the scale attached to the left side of the diagram will enable the reader to measure the amount represented by the curves.

By way of illustration I will give a detail of the 3rd series of experiments. It consisted of an inquiry into the effect of 100 grains of black tea, on April 2, in the morning, with a temperature of the air of 51 deg. and 53.5 deg. by the wet and dry bulb of the thermometer. There were six experiments; the first commenced at ten minutes, and the last at fifty minutes after the tea had been taken. The basis quantity of carbonic acid evolved by Dr. Smith was 8.33 grains, and by Mr. Moul 7.98 grains per minute, and there was a maximum increase of 1.72 grains per minute by the former in fifty minutes, and of 1.3 grains per minute by the latter in one hour and eleven minutes after the tea had been taken. The amounts of increase given at each experiment may be in like manner found, as may also the increase in the other three subjects of inquiry recorded below the curves of the carbonic acid.

It will be observed that there is an increase recorded in each of these subjects of inquiry in almost every experiment, as may be seen at a glance by carrying the eye along each basal line.

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